PREDICTING SEDIMENT AND PHOSPHORUS LOADS IN THE ROCK RIVER BASIN USING SWAT

Summary of August 2000 Study

Kevin Kirsch, WDNR

WISCONSIN
DEPT. OF NATURAL RESOURCES

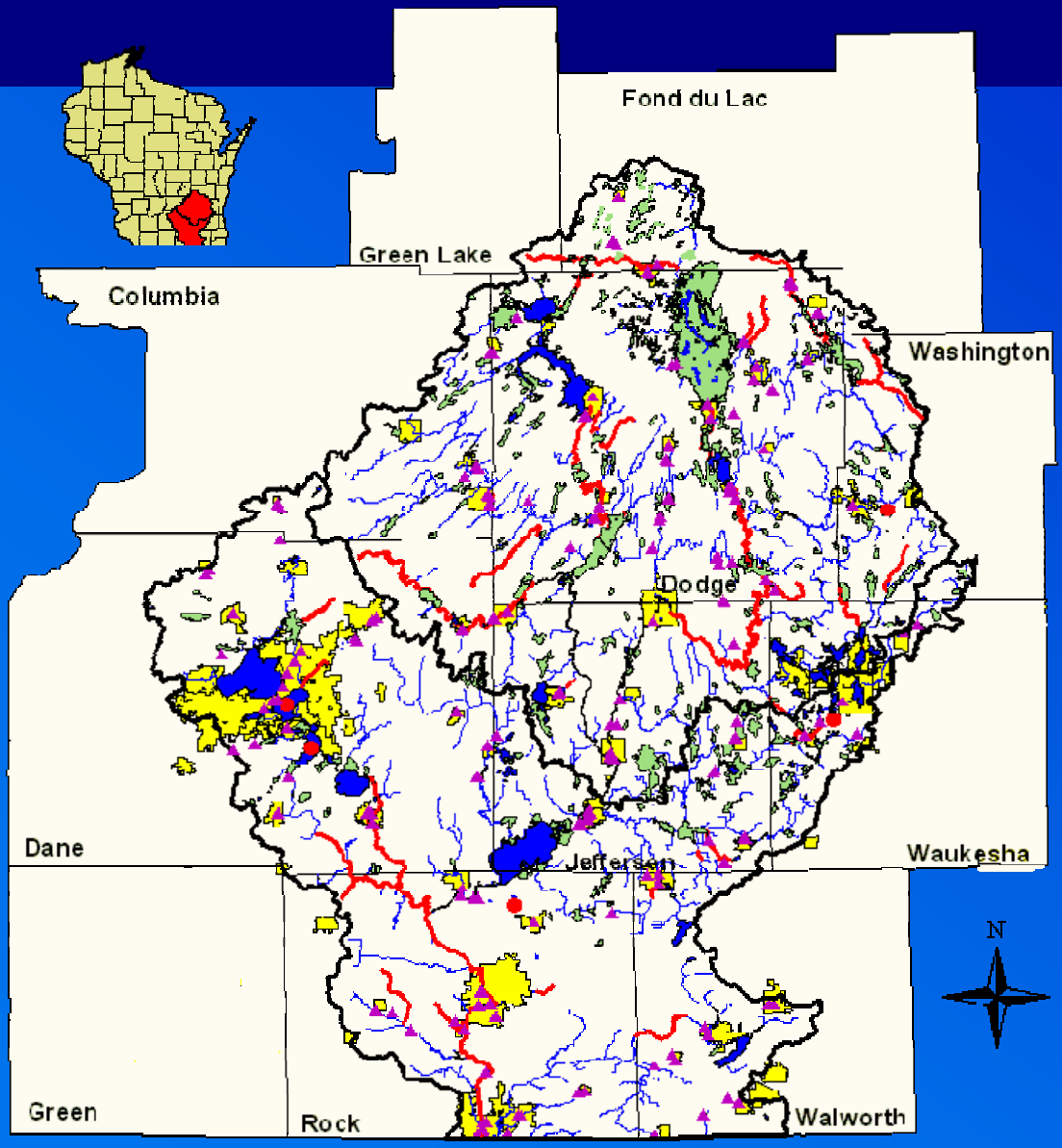
2000 Study Not a TMDL

While many steps are similar, the 2000 study was not a TMDL. The 2000 Study did not:

- **Assign load allocations based on targets**
- **Point vs non-point comparisons used traditional definition. In TMDL, all permitted sources are included in the waste load allocation (point source).**

WISCONSIN
DEPT. OF NATURAL RESOURCES

Rock River Basin



3,750 sq. miles

3,900 river miles

443 lakes/impoundments

WISCONSIN
DEPT. OF NATURAL RESOURCES

Rock River Basin: Land Use

Rock River: Project Background

"Partnership" formed under joint federal state, and local funding to conduct basin study to examine alternatives to NR 217

2000 Rock River Project

1. **Modeling effort using SWAT to quantify P-loads**
2. **Monitoring at nine USGS stations**
3. **Evaluation of pollutant trading**
4. **Biological impact assessment (UW-Study)**

WISCONSIN DEPT. OF NATURAL RESOURCES

Project Modeling Goals

- **Determine Phosphorus Loadings in Basin**
- **Quantify Point & NPS Loads**
- **Identify "Target" Areas**
- **Estimate Impact of BMP Practices**

WISCONSIN
DEPT. OF NATURAL RESOURCES

2000 Rock River Modeling

Used the basin scale Soil Water Assessment Tool model developed by USDA –ARS

At the time, was the largest most detailed modeling study conducted using SWAT.

Maintained existing WDNR basins and 28 watersheds boundaries and further delineated 116 Sub-watersheds and 1100 HRUs to capture characteristic land use, cropping practices, slopes and soils

WISCONSIN
DEPT. OF NATURAL RESOURCES

SWAT: Cropland Management

- **86 Management Files created for Rock River based on crops, tillage practices, and nutrient practices**

- **Examples:**

  6-year corn/forage rotation (dairy rotation)
  3-year corn/soybean rotation
  Vegetable rotation

WISCONSIN
DEPT. OF NATURAL RESOURCES

SWAT: Cropland Management

Sample Management File:
Corn-Forage Rotation

May	1	Apply Manure (20 tons/acre)
May	2	Disk (Adjust CN to 85)
May	10	Plant Corn (Set Harvest Index)
June	6	Adjust CN to 79
June	18	Row Cultivator
Oct	20	Harvest as Silage and Kill Crop
Oct	30	Apply Manure
Nov	2	Chisel Plow

WISCONSIN
DEPT. OF NATURAL RESOURCES

SWAT: Point Source Data

- Point Sources including POTWs, Industrial Sites, Canning Companies, and Cheese Factories
- 140 Point Source Files used in Rock River Model
- Used Average Monthly Values
- Input Flow, Nutrients, and Suspended Solids
- Data Gathered from Survey of Discharge Records, DNR Permits, and Literature Values

WISCONSIN
DEPT. OF NATURAL RESOURCES

SWAT: Lakes and Impoundments

- **Water Balance**
  Inflow, Outflow, Evaporation, and Withdrawals
- **Outflow** **Uncontrolled Outlet Structure**
  Controlled - Target Volume Approach
  Controlled - Daily Outflow File
- **Sediment (Discrete Particle Settling)**
- **Nutrient Losses (First Order Kinetics)**
- **Pesticides (Chemical Kinetics)**

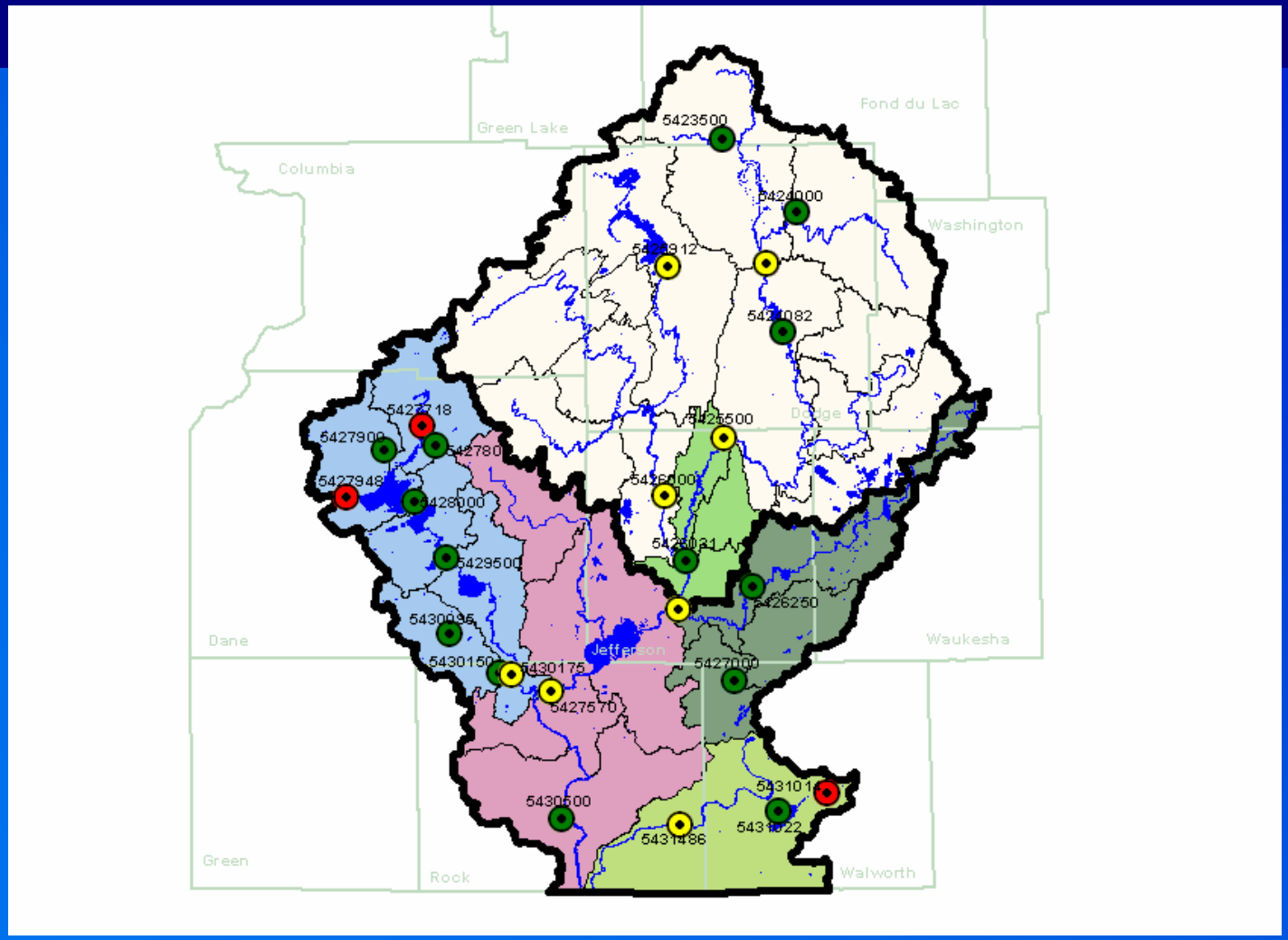
WISCONSIN
DEPT. OF NATURAL RESOURCES

SWAT : Urban Routine

- **Urban Build-up / wash off or the USGS Regression Equations**
- **Distinguishes between pervious and impervious areas**
- **Allows BMPs such as street sweeping**

WISCONSIN
DEPT. OF NATURAL RESOURCES

Rock River Basin: Calibration



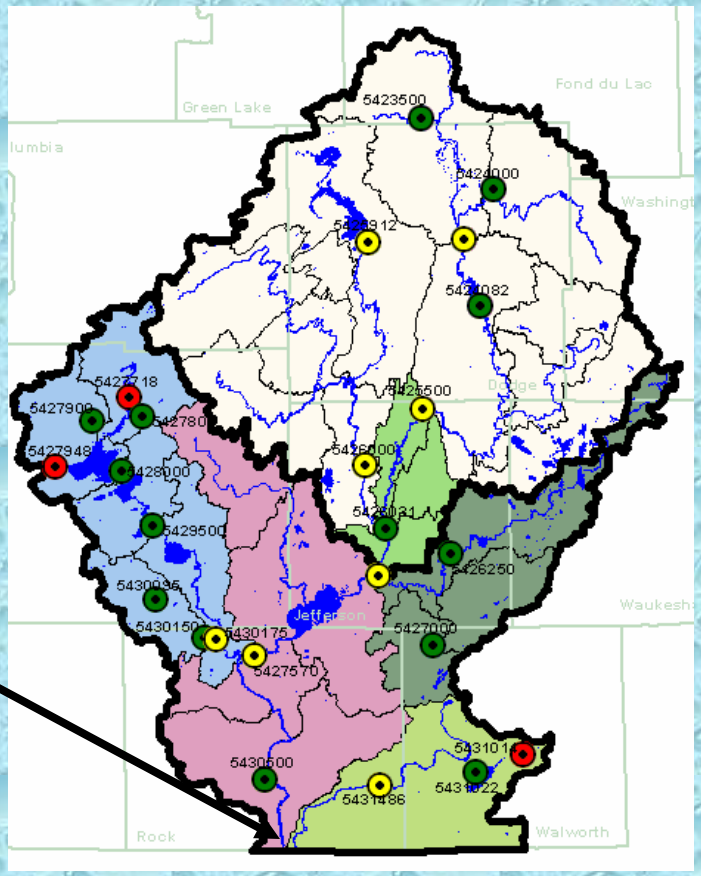
WISCONSIN
DEPT. OF NATURAL RESOURCES

Rock River Basin: Calibration

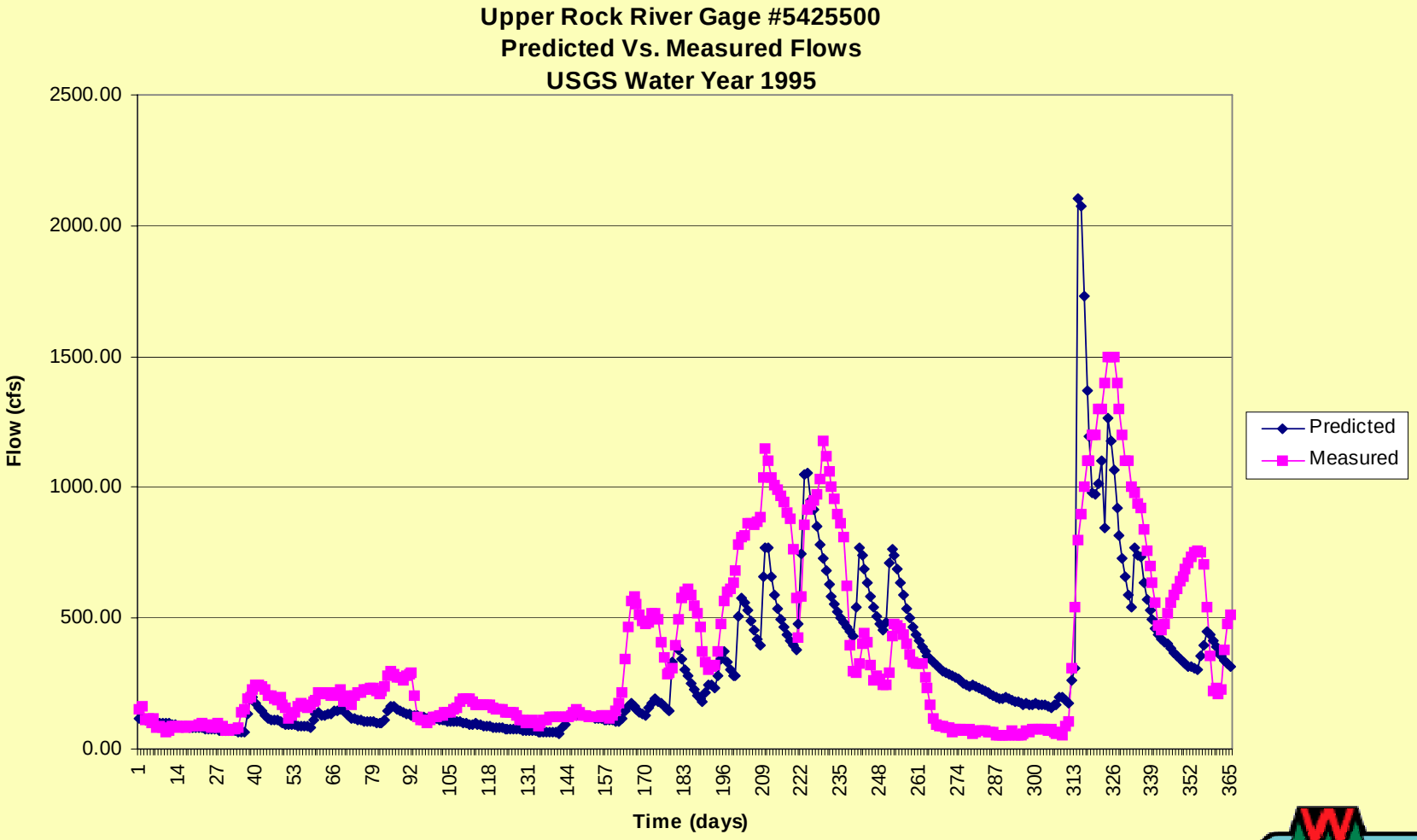
Annual Flows Rock River at Afton for 1989 to 1996 had 0% overall error with RSQ. Of 0.78 and COE of 0.76

Predicted = 70.85 inches

Measured = 70.63 inches



Rock River Basin: Calibration



WISCONSIN
DEPT. OF NATURAL RESOURCES

2000 Modeling Scenarios

Scenario	Tillage Practices	Nutrient Management	Point Source Loads
1	Current	Current	Current
2	Improved	Current	Current
3	Current	Improved	Current
4	Improved	Improved	Current
5	Current	Current	NR 217
6	Improved	Improved	NR 217

WISCONSIN
DEPT. OF NATURAL RESOURCES

2000 NPS Modeling Scenarios

<u>Improved Tillage Practices</u>:

Conventional tillage being changed to conservation tillage techniques and existing conservation tillage being phased into no-till for cash crops.

WISCONSIN
DEPT. OF NATURAL RESOURCES

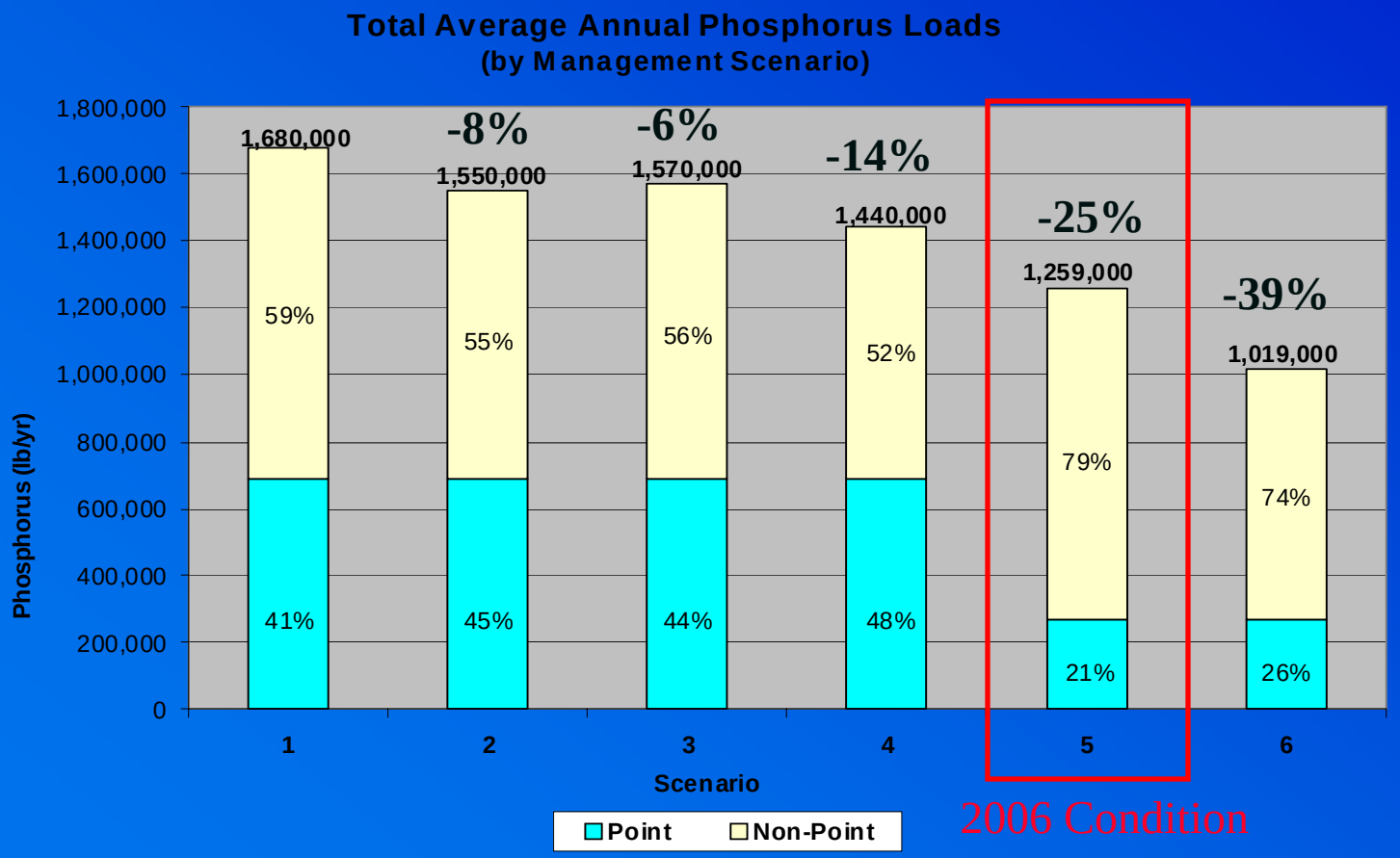
2000 NPS Modeling Scenarios

Nutrient Application Rates

Nutrient	Average Recommendation	Average Application	High Range of Application
Nitrogen	160 lbs/ac	188 lbs/ac	484 lbs/ac
Phosphorus	40 lbs/ac	91 lbs/ac	383 lbs/ac
Potassium	25 lbs/ac	207 lbs/ac	940 lbs/ac

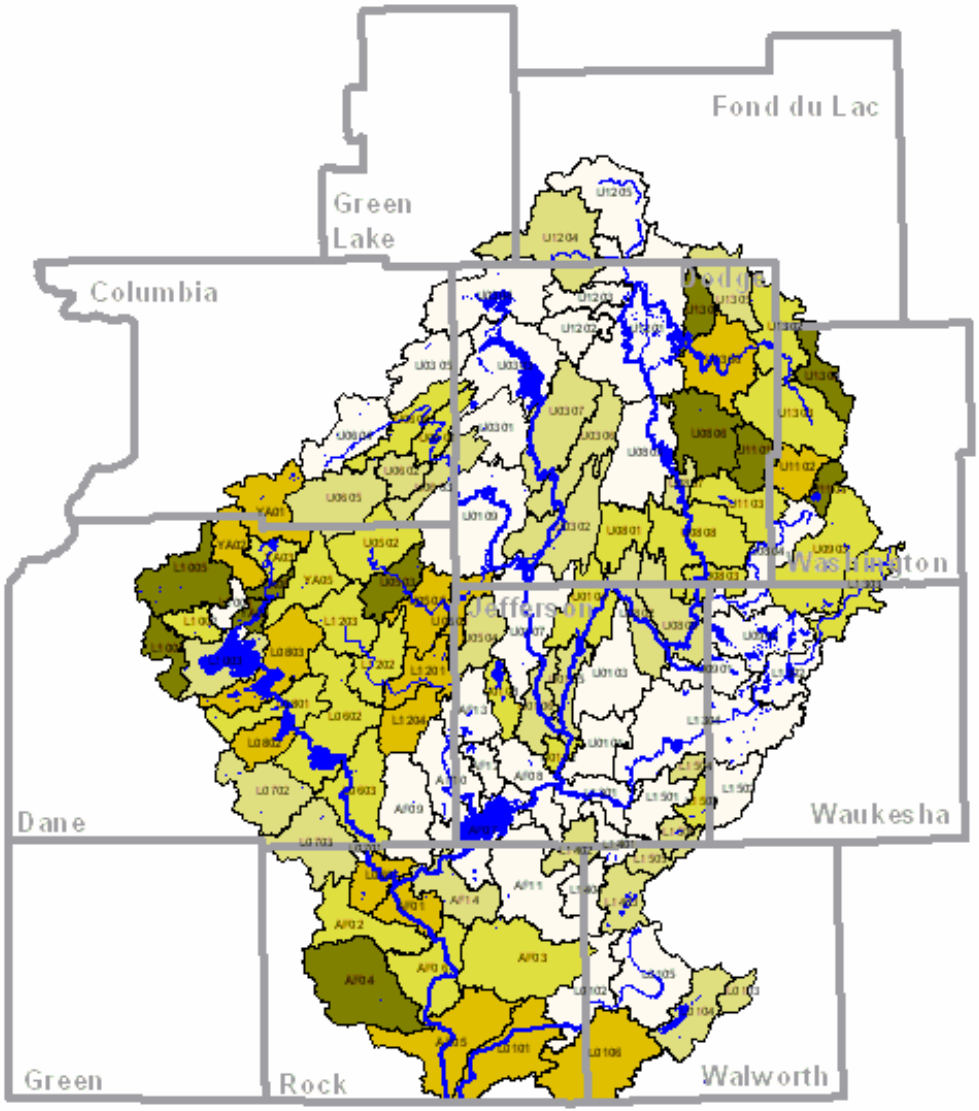
WISCONSIN
DEPT. OF NATURAL RESOURCES

Rock River Basin Wide 2000 Modeling Results

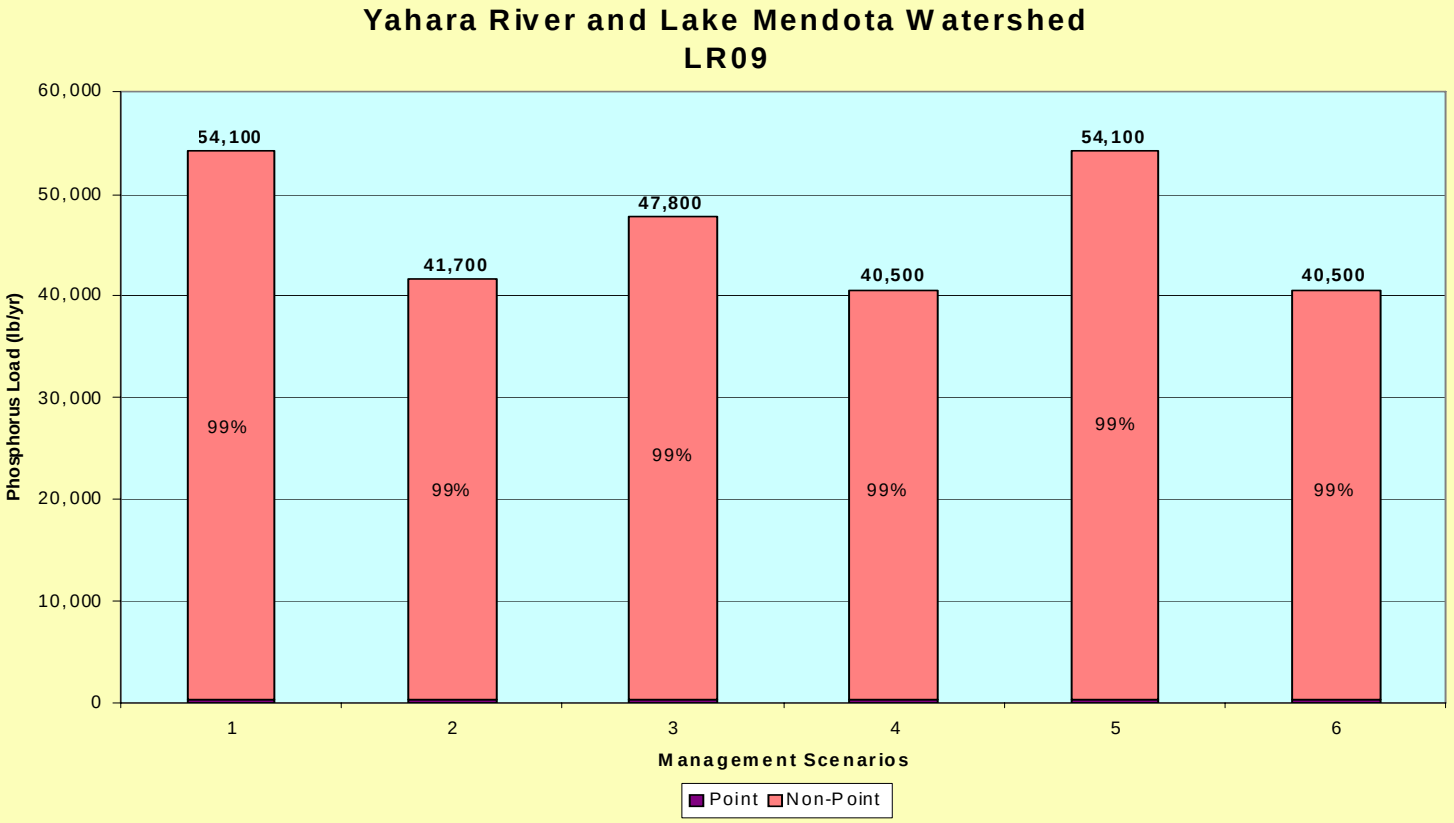


WISCONSIN DEPT. OF NATURAL RESOURCES

2000 Modeling Results: Target Areas

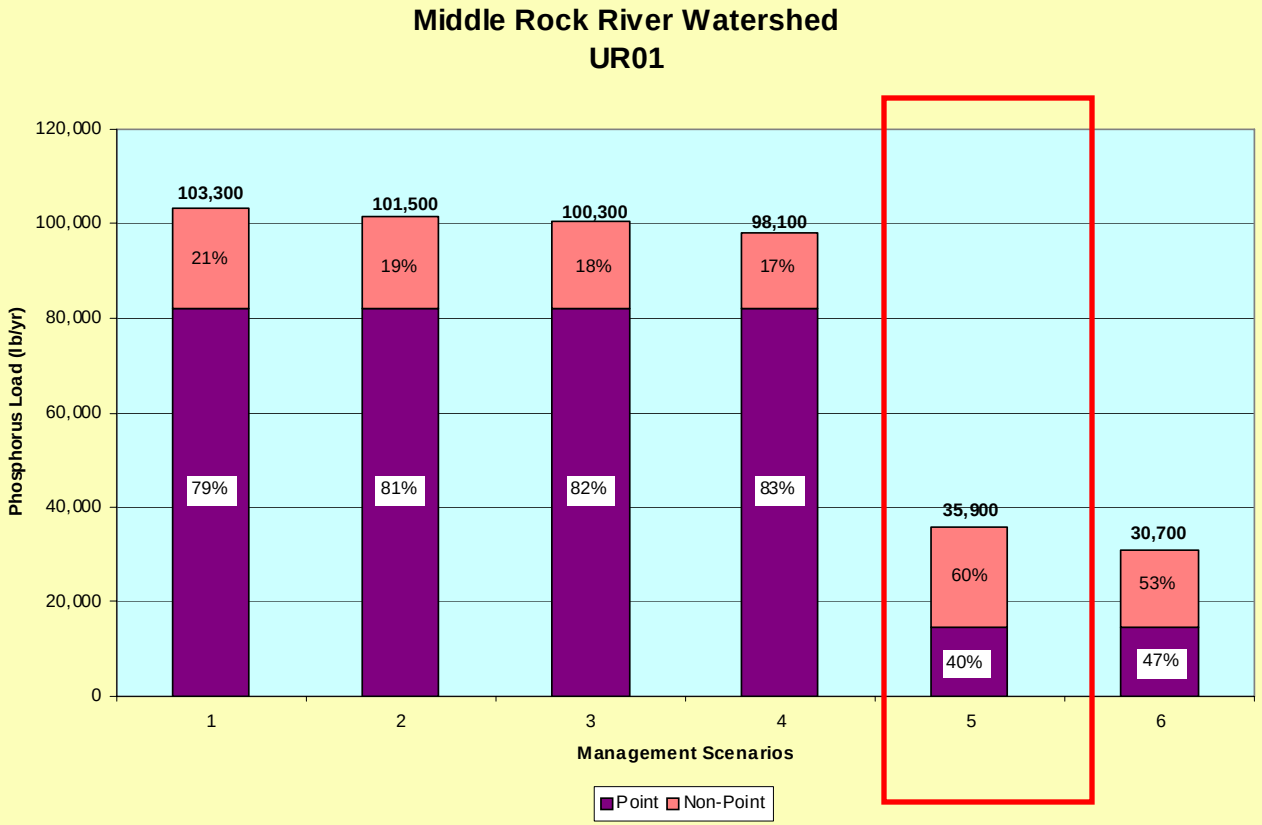


Rock River Basin: Modeling Results



WISCONSIN
DEPT. OF NATURAL RESOURCES

Rock River Basin: Modeling Results



2006 Condition

WISCONSIN DEPT. OF NATURAL RESOURCES

Pollutant Trading Pilot

Examined for point to non-point trades

Prime example of what happens when one jumps to conclusions instead of examining all the facts and conducting a logical analysis.

Presentation by Paul Faeth
World Resource Institute

Painted a more than optimistic and unrealistic picture of trading in the Rock River Basin.

WISCONSIN
DEPT. OF NATURAL RESOURCES

Pollutant Trading Pilot - Reality

(1) Published data from other national studies conducted at the time showed pollutant trading was not economically feasible until point sources were going below 1 mg/l phosphorus.

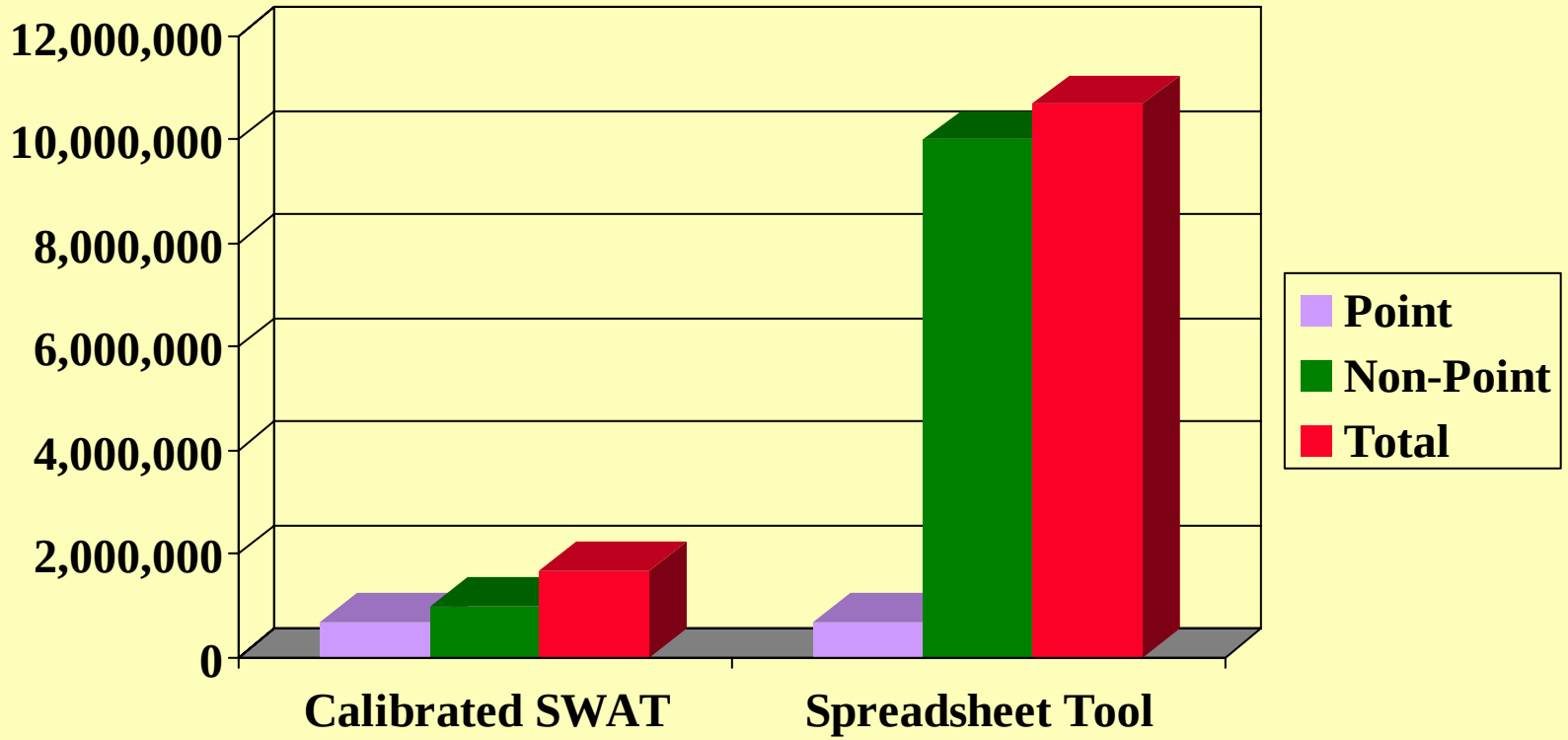
(2) The cost estimates for plant upgrades to comply with NR 217 were not always accurate.

(3) Did not have adequate tools to evaluate trades with non-point sources and low hanging fruit had already been addressed.

WISCONSIN
DEPT. OF NATURAL RESOURCES

Comparison of Methods

Predicted Pounds of Total Phosphorus



WISCONSIN DEPT. OF NATURAL RESOURCES

Continuing to Improve on Success

- **We have the frame work and tools in place for potential future trading.**
- **We have many of the loads and sources of sediment and phosphorus characterized.**
- **We have a calibrated model to build-on.**
- **We have an established stakeholder group.**

WISCONSIN
DEPT. OF NATURAL RESOURCES